Atomic Energy Control Board
P.O. Box 1046
Ottawa, Canada
K1P 5S9

Commission de contrôle de l'énergie atomique
C.P. 1046
Ottawa, Canada
K1P 5S9

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AECB STAFF ANNUAL REPORT OF BRUCE NGS"A" FOR THE YEAR 1990

June 1991

Canada

Report

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1. INTRODUCTION

The Atomic Energy Control Board (AECB) is the federal nuclear control agency. Its mission is "to ensure that the use of nuclear energy in Canada does not pose undue risk to health, safety, security and the environment".

It exercises control through a regulatory system that establishes the health, safety, security and environmental standards for all uses of nuclear energy and licenses only those that can meet and maintain those standards. At all nuclear generating stations the AECB has resident staff who carefully monitor station operation and enforce licensing conditions.

At Bruce NGS"A" this process requires that the on-site staff, in cooperation with AECB staff in Ottawa, monitors reactor operations, conducts audits and inspections, witnesses important activities and reviews station documents and reports from Ontario Hydro, the licensee.

A formal Annual Review Meeting is held with the station management and senior staff in order to discuss safety-related issues and to present to Ontario Hydro the AECB staff assessment of station operation during the year. This meeting is convened following the preparation, in draft form, of an AECB Staff Review of Station Operation. This report is compiled using, amongst other information, Ontario Hydro Quarterly Reports. These are a requirement of the licence and summarize key features of station operation during the year.

This report presents the AECB staff review of major licensing issues and the operational performance during 1990. In addition to the Quarterly Reports mentioned above, other Ontario Hydro reports, official correspondence and observations of the AECB site staff have been taken into consideration. The report is limited to those aspects of station performance that AECB staff considers to have some safety significance. Where items of significance, associated with issues addressed in the report, occurred early in 1991 these are also mentioned.

2. STATION OPERATION

2.1 Station Performance

The station's net Capacity Factor, (the ratio of achieved electrical output to designed maximum output), for 1990 was 47.39%. This figure shows a further reduction on that achieved in 1989, (53.55%), and reduces the lifetime ("since in service") capacity factor to 74.64%. This reduction is due, once again, to lengthy unit outages. In fact four unit operation existed for a period of only a few days in June during the year.

The year commenced with Unit 2 still shut down from the outage that started in March 1989 and with Unit 1 only able to operate at a power level of 78% due to boiler level oscillations. On January 23 an unintentional movement of the fuelling machine whilst refuelling Unit 4 caused a major release of heavy water to containment. This unintentional movement is discussed in greater detail in Section 3.5.1. The subsequent forced Unit outage lasted until July.

The following major unit outages occurred during the year:

UNIT 1

From 90-04-03 to 90-04-08, 5 days
Sudden outage due to turbine generator voltage regulator problems.

From 90-07-20 to 90-12-31, 164 days
Planned outage to clean boilers and inspect pressure tubes. (Outage continued beyond year's end.)

UNIT 2

From 90-01-01 to 90-05-24, 144 days.
This was a continuation of an outage which commenced 89-03-30. Total outage duration was 531 days. Major maintenance of unit systems, pressure tube inspection and boiler cleaning occurred.

From 90-05-27 to 90-06-14, 18 days
Forced outage due to failure of shutdown system detectors.

From 90-08-24 to 90-08-28, 4 days.
Forced outage to repair brakes on fuelling machine bridge.

From 90-11-06 to 90-12-31, 55 days.
Forced outage due to boiler tube leak. The leaking tube was located and plugged. Some pressure tube inspections were also carried out. The unit remained shut down at year's end.

UNIT 3

From 90-01-21 to 90-02-01, 10 days.
Forced outage due to heat transport system leak inside containment.

From 90-02-15 to 90-02-18, 2.5 days.
Forced outage due to failure of boiler safety valve to reset after test.

From 90-06-28 to 90-07-15, 17 days.
Forced outage to repair heat transport leak at bleed condenser gasket.

From 90-09-25 to 90-10-04, 9 days.
Forced outage to repair heat transport system leak.

UNIT 4

From 90-01-23 to 90-07-05, 163 days.
Forced outage to repair damage caused by inadvertent movement of fuelling machine during fuelling.

The total outage time for all reactor units in 1990 approached 600 days. A significant portion of this time was due to manpower and equipment shortages. The station cannot easily handle outages on more than one unit at a time. Under these circumstances the majority of available resources are directed towards the unit which can most easily be returned to economic production. This was most evident early in the year when resources were concentrated to return Unit 2 to service at the expense of Unit 4 and again later in the year when work on Unit 1 was reduced in order to repair the boiler tube leak on Unit 2.

It has also become evident that the procurement of spare parts is becoming more difficult. Many of the original manufacturers of station equipment either no longer produce an identical product or have gone out of business.

The Bruce Nuclear Power Development, of which Bruce NGS"A" is a part, still suffers from the problem of locked-in power. A new 500kV dual circuit transmission line came into service as planned late in 1990. However, when Ontario Hydro is purchasing power from Michigan, the flow away from the Bruce complex still has to be reduced due to lack of capability of transmission lines in southwestern Ontario to Toronto. This problem can require reactor power outputs to be reduced at the Bruce site.

2.2 Unit Operation at High Power

All units are licensed to operate at 100% power. However, as in 1989, very little operation took place at above 95% full power. This was as a result of the previously mentioned transmission line problems and self-imposed fuel channel power limits by Ontario Hydro until trip coverage due to the loss of a single heat transport pump can be accommodated automatically.

Late in the year the results of the reanalysis of the Simulation of Reactor Operation (SORO) computer code showed that a revised error band figure of 2% was justified. This will allow an increase in reactor power output of approximately 1.5%. (SORO is a computer simulation used to ensure that the reactor is operated within the power limits specified in the licence.)

Boiler Level Oscillations

This phenomenon, previously reported on in 1988 and 1989, continued to be a major limitation to high power operation of Unit 1. The unit was operating at 78% as the year began but when shut down for repairs in July, the maximum safe achievable output was only 55% of full power.

The scale build-up in Unit 1, which was restricting flow through the boiler tube support plates and therefore causing the oscillations, was successfully removed by water lancing. There is positive indication that the results obtained on Unit 1 surpass those previously achieved on Unit 2.

Unit 2 was successfully returned to high power operation with no oscillations recurring.

It is still planned to chemically clean the boilers to remove scale from the tubes. A trial clean of a boiler in Unit 2 is planned for 1992.

3. AECB STAFF REVIEW OF OPERATIONAL SAFETY ASPECTS

3.1 Station Compliance

The operation of the station must comply with the Atomic Energy Control Regulations, the Physical Security Regulations and conditions in the operating licence.

A standard licence condition is that the operation of the facility shall be governed by, and in accordance with, the document entitled "Operating Policies and Principles" (OP&P). The OP&P refer to various operating and maintenance

procedures that are carried out in the operation of the station. Station compliance is measured against the licence or the OP&P.

3.1.1 Compliance with Regulations

It is the opinion of AECB staff that the circumstances which caused a violation in 1989, incorrectly authorized removal of radioactive material from site, have been addressed.

However, Significant Event Report SER 90-134, which relates to the use of non-standard depleted fuel bundles, indicates that Ontario Hydro's Nuclear Generating Division, and in particular the department responsible for fuel procurement, has caused the station to be in violation of Part IV of the Atomic Energy Control Regulations. This section sets out the requirements for the licensee with respect to records and inspection of prescribed materials. In this instance the station was unaware that it was loading bundles containing 0.5% uranium 235 into the reactor instead of the expected 0.4%. Full details of the circumstances relating to this event appear in section 3.5.1.

3.1.2 Compliance with the Licence

Ontario Hydro has made reasonable effort to comply with the conditions of its Power Reactor Operating Licence. There were, however, some violations.

3.1.2.1 Compliance with Operating Policies and Principles (Condition A.A.1)

Ten (10) events were reported which represented violations of the station OP&P. These events are discussed further in section 3.7.

3.1.2.2 Compliance with Ontario Hydro's Radiation Protection Regulations (Condition A.A.1)

AECB staff review of significant events involving radiation control incidents has concluded that none of them represented a breach of this condition. There were no instances of personnel receiving radiation doses in excess of regulatory limits during the year.

3.1.2.3 Maintenance (Condition A.A.11)

As is discussed in section 4.1, and as has been clearly stated in the three previous reports, AECB staff are not yet satisfied that maintenance standards at Bruce NGS"A" fully meet the requirements of the licence condition:

"A.A.11 Maintenance of the nuclear facility shall be of such a standard that, in the opinion of the Board, the reliability and effectiveness of all equipment and systems as claimed in the Safety Report and documents listed in the application are assured".

Ontario Hydro has, however, made great efforts to improve this situation and positive effects of these efforts are being noticed. The additions to the station complement over the past years are now beginning to produce improvements.

Standards of housekeeping have, in general, continued to show improvement. One serious omission from this general trend has been in the management of Rubber Areas. These are special areas set up to control the spread of radioactivity, usually resulting from maintenance activities, and their operation is carefully defined in the Radiation Protection Procedures. On occasion during the year, AECB staff has found it necessary to report to the station serious deficiencies in the use and maintenance of Rubber Areas. This is an area where we shall expect a marked improvement in standards in the immediate future.

The Maintenance Support Group, which was reported as a positive introduction in last year's report, has started to produce procedures and obtain equipment to improve the maintenance and calibration of plant equipment and systems. One example of this was the introduction of a program to maintain Steam Traps. AECB staff welcomes these initiatives and will monitor the programs to determine their effectiveness.

These initiatives are encompassed in the Nuclear Generation Quality Improvement Program (QIP). This program is now beginning to show evidence of movement in a positive direction. The initiative to increase individual "employee ownership" in day to day operations is viewed by AECB staff as an important feature of QIP.

3.1.2.4 Testing (Condition A.A.13)

The good record of completing safety system tests on time was continued in 1990. Only a very small proportion of on-power Safety System tests (less than 1.5%), were not completed on schedule. The reasons for non-completion or delay were satisfactorily explained by the licensee.

3.1.3 AECB Staff Comment on Compliance with Bruce NGS"A" Reactor Operating Licence During 1990

Station Management once again made determined efforts to comply with the licence requirements during 1990. All of the identified cases where licence conditions were breached were accidental and appropriate steps were initiated to prevent recurrence.

With the exception of Safety Report updates, the timeliness of submission of required technical reports was maintained. The licence requirement (Condition A.A.12) for the presentation of reports, tests, modifications and analyses was, in the main, achieved throughout the year.

It was also apparent that station management made determined efforts to ensure that OP&P requirements were met. A training course for Technical and Operations personnel was developed and delivered. AECB staff attended this training and it was apparent that great efforts had been made to impress upon staff who are not directly concerned in the moment to moment operation of the station, e.g. technical unit personnel, that their work output, in the form of work plans etc, must also ensure that OP&P are adhered to.

3.2 Ontario Hydro Station Quarterly Reports

The four Quarterly Reports were produced on schedule and were reviewed by AECB staff. These reports contain detailed information on all aspects of performance of station reactor units, safety systems and safety-related

activities such as chemical and radiation control and the handling of prescribed substances. The reports also include data relating to safety system reliability assessments, faults and predictions for the future availability of safety systems. AECB staff found the reports to be clear, and as far as could be ascertained, accurate records of station performance and events.

3.3 Radiation Protection

No member of station staff received a radiation exposure in excess of the legal limits during 1990. Accumulated dose for station staff showed a further significant reduction in 1990, a commendable achievement considering the amount of maintenance activity in progress throughout the year. Neutron dose, although showing some increase over the 1989 figure, was maintained at a low figure.

Although there were again a number of radiation incidents resulting in unit alerts during the year, it is apparent that procedures were, in general, adhered to and that radiation dose reduction continues to have a high priority. The aforementioned concern with the housekeeping of Rubber Areas is the only major one in this area.

This added attention is also likely reflected in the number of incidents requiring a supervisor's investigation. The number of these investigations fell to 31 in 1990 from 43 in 1989.

3.4 Station Effluents and Environmental Monitoring

The station gaseous, waterborne emissions and environmental monitoring measurements are shown in Appendix II, Objective Measures. There were no emissions from the station which exceeded the 1% Derived Emission Limit (DEL) weekly target.

Despite these commendable results the licensee's commitment to commission the new Liquid Effluent Monitor (LEM) and upgraded gaseous effluent monitoring equipment has not yet been met. In service target dates have again passed.

3.5 Process Systems

3.5.1 Reactor Process, Control and Fuel Handling Systems

Tritium in Steam

Bruce NGS"A" is unique among currently operating CANDU nuclear stations in that a portion of its steam is used for purposes other than for driving the turbine. Approximately 10% of the produced steam is currently supplied to the Bruce Steam Transformer Plant to provide process steam for the Heavy Water Plant and building heating for facilities at the Bruce site. A further load on the Steam Transformer Plant is to provide steam to the Bruce Energy Centre, an industrial complex located about 4km east of Bruce NGS"A".

The tritium which is produced in the Heat Transport System as a result of using heavy water as a coolant, is prevented from reaching the users of the process steam by a system of barriers. These comprise:

the boiler tubes at Bruce NGS"A";

the reboilers and subcoolers at the Steam Transformer Plant;

heat exchangers at the Bruce Energy Centre (BEC).
Note that to date only two of the three current users at the BEC have heat exchangers. The ethanol production plant, operated by Sunroot Ltd, does not have a heat exchanger as yet.

In September a boiler tube leak in Unit 2 resulted in high (3.52 MBq/kg) levels of tritium in the high pressure steam to the Steam Transformer Plant (STP). Due to leaks in the reboiler tubes at the STP the tritium levels on the secondary side rose to 89 kBq/kg. The offending reboiler was shut down. Samples from the BEC indicated tritium levels of up to 126 kBq/kg. Air samples and bioassay (urine) samples from personnel at the BEC did not indicate any significant increases in concentrations.

An immediate action was to establish levels of tritium at which the steam supply would be isolated to minimize any uptake of tritium by workers at STP and BEC. In addition, a pathway analysis was undertaken to ensure that the action levels set were adequate to ensure that workers at the STP and BEC could not exceed the dose limits for the general public.

To further reduce the dose potential, Ontario Hydro has established a reboiler rehabilitation and maintenance program and the ethanol plant is planning the installation of heat exchangers.

It is the opinion of the AECB that the measures described above are sufficient to ensure that any hazard resulting from the presence of tritium in steam from Bruce NGS"A" presents an insignificant increase in risk to workers at the STP and BEC.

In addition, AECB staff has reviewed the shutdown criteria at Bruce NGS"A" for leaking boiler tubes and has found them to be adequate. Tritium monitoring, for a boiler with no tube leaks, will be done on a once per shift basis. The detection of a leak will require the sampling frequency to be increased.

Moderator Overpoisoned Guaranteed Shutdown State

The Moderator Overpoisoned Guaranteed Shutdown State (OPGSS) is put in place to ensure that reactor power, when in the shutdown state, cannot increase under any circumstance. It is achieved by dissolving a neutron absorbing poison, gadolinium nitrate, into the moderator heavy water to prevent such an increase in power and then ensuring that this poison level is maintained.

On two occasions, during the year whilst in the OPGSS, actions were taken which led to the guaranteed state being compromised. The first instance was reported in Significant Event Report SER 90-018 for Unit 2. Maintenance activities during the long shut down of this unit had resulted in the removal of interlocks from valves which normally route the circulating flow of moderator D2O around the system. This resulted in an inability to ensure that a wholly representative sample of moderator D2O could be obtained to verify the gadolinium concentration was within specification.

On the second occasion, an operator inadvertantly returned to service an incorrect circuit breaker making it possible to start the main moderator circulating pumps. The condition guarantee requires that these pumps remain isolated to prevent the possibility of diverting D2O to the ion exchange

columns which can remove gadolinium and thus reduce the poison concentration. AECB staff have requested the station to immediately review its procedures for applying and maintaining the OPGSS.

Fuelling Machine Incident

In the early hours of January 23, 1990 a potentially serious event occurred on Unit 3 when an unplanned movement of a fuelling machine took place when it was attached to reactor channel C08 of Unit 4.

On this occasion, while one machine was fuelling Unit 4, there was a second machine involved in operations at the Central Service Area. Due to a software error, a computer generated command intended for this second machine was received by the machine attached to channel C08 on Unit 4. The result was that the carriage which normally supports the machine when at the reactor was lowered, by about 30cm, causing the considerable weight of the fuelling machine to be supported solely by the channel end-fitting. This caused the end-fitting to deflect and resulted in a large leak of heavy water from the heat transport system at the fuelling machine-to-channel seal area.

Operator response to the event was prompt and correct and the unit was successfully shut down without fuel damage occurring and with no release of radioactive materials to the environment. The shutdown was not achieved, however, without difficulty due to several equipment failures. In particular, the shutdown cooling system had to be operated manually due to the failure of a temperature control valve. At a later stage in the shutdown, non-standard operation of the maintenance cooling system was necessary due to a valve failure.

The offending software error was subsequently found to have been present for some time and only manifested itself due to the particular set of conditions that were present during this fuelling operation. A thorough review of the fuel handling control software was required to locate the error.

Problems Regarding The Use of Depleted Fuel

The ongoing inspection program for fuel channels and fuel channel replacement requires that fuel be removed from the channel and then subsequently replaced by depleted fuel.

Unfortunately, and unknown to Bruce "A" station staff, a batch of depleted fuel had been manufactured by Canadian General Electric with a uranium 235 content of 0.5% rather than the usual 0.4% U235. Some 108 of these bundles were loaded into units 1,2 & 3 at various times between February 1989 and July 1990. On one unit, Unit 3, station staff noticed atypical reactor behaviour following the restart of the unit and adjusted safety system trip parameters to take account of the observed anomalies. However, in spite of these precautions, later analysis has shown that safety system margins were impaired for periods of up to two months during 1989 and 1990.

This event was caused by a combination of poor record-keeping and material control procedures external to Bruce NGS"A" and has already been commented upon as a violation of the Atomic Energy Control Regulations in section 3.1.1.

3.5.2 Secondary Systems

As occurred last year, there were a number of significant events which resulted in a steam drum to heat transport temperature differential excursion over and above the limits imposed by the Steam Drum Operating Diagram (SOD) control program. Again these events were the result of another event or connected with a unit start up or cooldown. The required analysis following each event confirmed that code allowable stresses had not been exceeded.

The issue of frequent SOD temperature excursions during unit power manoeuvers was investigated by a team of consultants hired by Ontario Hydro to study operational complexity at Bruce NGS"A". Their findings indicated that reactor operators do not consider the SOD limits to be a major operational problem. However, a design solution to reduce the frequency of such events was recommended by the team and is included in the scope of an approved rehabilitation program.

A further secondary side incident concerned the overpressurization, by a factor of four, of the suction side of a boiler feed pump on Unit 3. The cause was determined to be a passing valve. This incident has disturbing similarities to a event at Surrey NGS in the United States when overpressurization of a pump suction line caused the failure of an expansion joint and the death of an operator.

3.6 Special Safety Systems

3.6.1 Shutdown Systems

Shutdown System 1 (SDS1) was available on all units not in a guaranteed shutdown state at all times throughout the year. There were no reactor trips from high power on any unit during the year. There were, however, a number of trips on shutdown units during the course of the year. These were all reported to the AECB and in all instances were attributable to maintenance activities or electrical "noise".

The systematic replacement of mercury wetted relays which are prone to sticking in the closed position possibly causing a shut-off rod not to drop when required, with the improved "tin-doped" variant continued. To date there has been no record of a replacement relay failure at Bruce NGS"A".

Significant Event Report SER 90-135 reported the non-standard output of a power supply which provides the power to energize the clutches which hold the rods out of the core. The voltage was found to be 130v instead of the required 90v. This higher voltage has two possible detrimental effects on performance. Firstly, the time required to fully de-energize the clutch will be increased. This increase was calculated as not significant, a few milli-seconds. Secondly, the additional voltage would add to the heating experienced by the clutch coils and plates. However, inspection indicated no apparent deterioration.

Shutdown System 2 (SDS2) was fully available at all times except for a period of 18 days on Unit 2, attributed to the loading of depleted fuel bundles with an increased percentage of uranium 235. This resulted in a level 2 impairment (a reduction in effectiveness) due to a reduction in trip margins.

3.6.2 Emergency Coolant Injection (ECI)

The reported unavailability for this system for 1990 was 0.52 x 10-3 yr/yr (4 hrs per year) which meets the target figure of 1 x 10-3 yr/yr (8 hrs per year). The recorded unavailability was due to two separate events. One was when an auxiliary pressure relief valve in containment opened spuriously. This caused a considerable fall in containment pressure since containment was now connected to the vacuum building via the opened valve. This decreased pressure has been calculated to show that ECI initiation, which is partly based on rising containment pressure, could be delayed should an incident require its operation. The second impairment was caused by the failure of the valves connecting the Grade Level Water Storage Tank (a secondary source of water) to the system to open under test conditions.

The performance of ECI in 1990 showed a marked improvement over that achieved in 1989 when targets were exceeded by large margins.

3.6.3 Negative Pressure Containment

Once again during 1990, Containment failed to meet its unavailability target of 1 x 10-3 yr/yr (8 hrs per year). The figure attained was 78.7 x 10-3 yr/yr (688 hrs per year). This high level unavailability was due to three separate incidents.

Firstly, an unavailability of 229 hours occurred when it was found that an intended discharge path through a charcoal filter did not exist due to the incorrect positioning of the damper indicator. This incorrect positioning showed the damper to be open when it was closed. This is not the first time that such a fault has occurred.

The second main contributor was non-availability of the instrumented pressure relief valves (IPRV) for 456 hrs whilst engineering work was in progress. Again the problem was traced to a mispositioned valve. The valve position indicator for the mispositioned valve was later found to be very difficult, if not impossible, to observe from the operating position.

On the third occasion, it was found that an airlock had lower than the required air pressure supplied to its inflatable door seals. The impairment lasted for 3.5 hrs.

Containment leak tightness continues to only marginally meet the operational limit of 2% vol/hr. Indeed on some occasions the results obtained in 1990 were worse than those achieved in 1989. The reasons for this have not yet been satisfactorily explained by Ontario Hydro. Testing has been carried out on a regular quarterly basis. Discussions with Ontario Hydro continue in a effort to produce solutions to resolve this long-standing problem.

3.7 Significant Events

In 1990 one hundred and forty three (143) Significant Event Reports (SERs) were generated at Bruce NGS"A"; none of these were attributable to serious process failures but 42 reports were pursuant to the Bruce NGS"A" operating licence. The total number of events is more than that of the previous year (127) but the number of reportable events is lower than the 58 reported in 1989.

The increase in the total number of SERs does not necessarily reflect a lowering of, or laxity in, operating standards. The "significance threshold" is set by station management and the evidence is that Bruce NGS"A" management sets a low threshold. It should be realized that SERs provide a useful means of feeding back information to station and other staff.

A comparison of events for the past two years shows where differences have occurred:

Event Category	Number of Reportable Events 1989	1990
Radiation Control	20	9
Shutdown Systems	10	5
Containment	3	4
Emergency Coolant Injection	2	1
Reactor Process Systems	19	11
Secondary Systems	0	6
Miscellaneous	4	6

As noted in Section 3.1.2.1, 10 events were designated as contravening OP&P. A brief summary of these events follows.

1. February 1990 - A hydrostatic test on the Shutdown Cooling System of Unit 2 was left unattended. During this period the pressurizing pump was left running with the result that the system was overpressurized by a factor of 1.45. The system had to undergo extensive further inspections to confirm that the pressure boundary had not been weakened inadvertently before the unit could be returned to service.

2. February 1990 - Due to incorrect valve positioning, over-pressure protection was removed from a moderator heat exchanger on Unit 2. This event also compromised the Overpoisoned Guaranteed Shutdown State which was in place on the unit at that time.

3. March 1990 - The use of incorrectly rated relays prevented full speed operation of the moderator auxiliary pumps on Unit 2. This could have resulted in overheating of reactivity control devices.

4. May 1990 - The suction side of a boiler feed pump on Unit 3 was pressurized to four times its normal working pressure. The likely cause was an isolation valve that had not closed completely.

5. May 1990 - Material used for reactor system maintenance was not of the required nuclear grade. This was a quality assurance procedural breakdown.

6. June 1990 - The heat transport heavy water storage tank level on Unit 1 was allowed to fall below 50%. This low level may have caused significant problems if the unit had been forced to shut down rapidly.

7. August 1990 - Another example of non-nuclear grade components being found on a nuclear system.

8. October 1990 - The moderator overpoisoned (safe) state on Unit 3 was compromised by incorrectly putting into service the circuit breaker for the moderator pump.

9. November 1990 - Depleted fuel bundles containing an incorrect amount of uranium 235 were used during the restarts of Units 1, 2 and 3. This was a case of poor material control.

10. December 1990 - A unauthorized form of dummy fuse was fitted to the control circuit of a Heat Transport System pump motor. The motor failed to trip on demand.

All of these events were reviewed by AECB staff and the licensee's proposed actions to prevent recurrence were considered to be appropriate.

Events in which human factors played a role totalled 43 in 1990. This is a further decrease from those noted in 1989. This can be taken as further evidence that operating quality continues to show improvement. AECB staff continue to recognize that the Human Performance Enhancement System (HPES) fulfills a useful function in the analysis of events with human factors as an element.

3.8 Quality Assurance

One quality assurance (QA) audit was conducted by AECB staff during 1990 in the month of July. The audit covered the following areas:

Control of jumpers (temporary changes)
Safety and Relief Valve Testing
Material Control
Preventative Maintenance
Quality Assurance Monitoring
Maintenance of Safety Systems
Training of Maintainers of Special Safety Systems
Preparation of Maintenance Procedures.

The auditors found that there were no major deficiencies in any of the areas with the exception of material control. They concluded that a significant effort has been made to improve the operational control of most of the subject areas covered by the audit.

In addition to raising a Quality Observation Action Notice on material control, the auditors made a recommendation that the station QA group conduct an in-depth audit of material control at the station with particular emphasis on the control of nuclear grade materials.

The station QA manual was revised and re-issued in the spring of 1990. An AECB staff review of this revision found it to be a significant improvement over previous revisions. A further revision, to reflect more precisely the requirements of the CSA standard N286.5 and the changes in the station organization, was issued in February 1991.

AECB staff is encouraged by the recent changes in QA policy at the station and by the decision to increase the QA group staff compliment to five. A further increase of two is expected to cover the additional responsibilities of the group associated with the Bruce NGS"A" rehabilitation program.

3.9 Maintenance

This topic is discussed in section 4.1.

3.10 Chemistry Control

The average overall station chemistry control performance achieved over the year was 79.8% as assessed against a division target of 90% and a station target, considered achievable, of 85%. The figure shows a further improvement on that reached in 1989. The shortfall can be largely attributed to the inability to consistently maintain boiler feedwater pH and conductivity levels within specified limits. The control of these parameters is a manual system. An automatic system, which should improve matters, has been designed but has not yet received installation approval.

AECB staff is encouraged to see the improvement towards the target figure.

3.11 Station Management

While it is apparent that the trend of increased staff involvement in the process of management reported in last year's review has been continued, positive results from this process are not always immediately obvious.

Cooperation from Ontario Hydro staff at all levels remains excellent. Communication has been effective. Advance notification of potential safety concerns, licensing issues and prompt notice of safety significant events or planned activities has always been provided in a timely manner by station management. A cautious and prudent approach has been consistently apparent. This level of cooperation continues to be appreciated by AECB staff.

3.12 Training

Bruce NGS"A" shift supervisor and first operator candidates maintained a high pass rate in 1990. The overall pass rate was 96% for shift supervisors and 100% for first operators.

One training deficiency noted was the inability of Ontario Hydro to have the necessary training programs in place to enable the implementation of the new operator structure. This new structure should improve the quality of field supervision. The delay in the introduction of this new structure is seen as a negative aspect of station operation but does not only apply to Bruce NGS"A".

3.13 Emergency Drills

Once again in 1990 a full schedule of emergency drills and exercises was planned and completed. A total of 52 such drills were held during the year, more or less equally distributed between the five shift crews.

In addition to the above, each operator is required to complete 18 emergency actions to retain familiarity with these tasks. Each of the five shift crews successfully completed its quota.

The appointment of a Quality Improvement Program Coordinator is a further indication of management's commitment to the improvement process.

AECB staff again considers that the attention given to emergency preparedness by

Bruce NGS"A" management during a period when manpower resources were at a premium is highly commendable.

3.14 Security

There were no security incidents at Bruce NGS"A" in 1990.

3.15 AECB Compliance Activities at Bruce NGS"A" in 1990

Introduction

There are three types of compliance activity by AECB site staff; rounds, individual system inspections and assessments.

Rounds form a system of designated tours of the whole plant to see that everything is in order, e.g. radiation hazard signs are in place and up to date, no water is leaking onto electrical equipment. Any anomalies found are reported to the Shift Supervisor by memorandum.

In system inspections, safety related systems in the plant are examined to a depth commensurate with their importance to safety to ensure that they are operated and maintained correctly and in accordance with station procedures. A report of the results are sent the Production Manager.

Assessments are made of plant operation activities to see that procedures are adhered to; typical examples are the restart of a reactor after a long outage and repair work on pressure boundaries. A detailed report of the results is sent to the Station Manager. All assessments are pre-planned and follow a standardized format.

Rounds

There are 68 rounds at Bruce NGS"A", roughly thirteen to each of the five units (Unit 0 included). These were completed about one and one half times during 1990.

The following were the most serious anomalies found and subsequently corrected.

1. Rubber Areas (i.e. controlled areas where contamination of the floor may occur from radioactive work) were not always found to be in accordance with the Radiation Protection Procedures. This is a recurring problem and has been exacerbated since the station entered the régime of extended outages for extensive maintenance and repair.

2. Identification tags missing from equipment.

3. Radiation hazard signs out of date or not in place.

4. A few instances of a valve not being locked in the required position to ensure the correct operation of a safety-related system.

5. Instructions for operation of the mobile heat transport auxiliary feed pump, which could be needed if the capacity of a unit's feed pump fell below sufficiency, were not in position on three units at the locations where the auxiliary pump would be used.

6. On two occasions tritiated heavy water was found to be leaking from equipment into the station.

System Inspections

Check lists for 20 systems at Bruce NGS"A" exist at present; more will be added as time and availability of staff permit. The check lists, prepared some time ago, are in the process of being updated to make them easier to use and to reflect the modified state of some systems. Nine systems were inspected during 1990, these were:

Reactor Regulating, Unit 3
Class III Electrical Power, Units 0 & 1
Fire Protection, Unit 0
Emergency Coolant Injection, Units 0 & 3
Interunit Feedwater Tie/Auxiliary Boiler Feedwater, Unit 1
Emergency Boiler Cooling, Unit 2
Containment, Unit 0
Shutdown System 1, Unit 3
Shutdown Cooling, Unit 2.

All systems were found to be in a generally satisfactory state.

Assessments

There are standard assessment plans for six activities. They are:

High Hazard Work
Guaranteed Reactor Shutdown State
Reactor Start-up after a long outage
Valve position check inside the vault
Pressure Boundary Work

No assessment was conducted in 1990 at Bruce NGS"A".

Conclusions

The number of instances in which it was found necessary to record situations when the found state did not match the expected state showed a decrease in 1990 to 38.5% from 48% in 1989.

When it was necessary to bring deficiencies to the attention of the station by means of memoranda, prompt remedial action was invariably carried out.

The nine systems which were able to be inspected were fewer than AECB would have hoped to achieve, staff resources and modifications to the process being the limiting factors.

3.16 Measures of Station Performance

1990 performance indicators and other objective measures are shown in Appendix II. An assessment of either "acceptable" or "needs action" is made by AECB staff following comparison with the previous year's figures. Most of the indicators are supported by comments in the appropriate section of this report. It should be noted that in many instances the assessment arrived at is not based on established criteria but represents a "consensus" view of AECB staff members who were closely involved with plant operation in 1990.

4. SIGNIFICANT LICENSING MATTERS

The AECB staff recommendation to the Board for renewal of the Bruce NGS"A" Operating Licence in November 1990, Board Member Document BMD 90-155, identified two main areas as licensing issues. These are briefly reviewed below:

4.1 Standards of Operation and Maintenance

As previously mentioned, there are positive signs that some standards at Bruce NGS"A" are showing measurable improvement. Housekeeping and preparation of Maintenance Procedures are two such examples.

The Quality Assurance Audit carried out at Bruce NGS"A" in 1990 reported in section 3.8 did not identify any major deficiencies.

The setting up and staffing of a Maintenance Support Group is viewed as a positive step. This group, although still short of resources, is beginning to introduce innovative techniques to improve the maintenance process in the station. The introduction of maintenance management programs, e.g. for steam traps, and a study of Reliability Centred Maintenance are two such examples.

Resources have also been allocated to improve and formalize the training for maintenance staff who work on safety systems. The training material, both in preparation and in use follows accepted training principles (i.e. objective based) set by the Institute of Nuclear Power Operators (INPO).

Procedures and methodology for the testing of safety and relief valves have also been improved.

A program has been started to review and re-issue control and mechanical maintenance procedures, to ensure technical correctness and commonality. Targets have been set and indications are that they are currently being met.

On the negative side, there still remains in the opinion of AECB staff, insufficient field supervision of maintenance work. The continued high level of maintenance activities has seen a disturbing increase in the number of SERs generated relating to either violations of work protection and control procedures or near miss accidents. While AECB staff acknowledge that this type of hazard is more likely during periods when large amounts of work are in progress, it is, nevertheless, thought that the number of such incidents during 1990 were excessive. AECB staff expects Bruce NGS"A" to consider methods to reduce the risks in this area.

AECB staff believes that the station must improve its capacity to complete planned work on time. Although this is largely an economic concern, it does have safety significance in that important safety-related maintenance and changes are jeopardized when programs slip and have to compete with requirements to operate the station.

If the current situation continues, the planned major rehabilitation program for Bruce NGS "A" may be unachievable, and the effects of aging plant components will acquire a greater safety significance.

AECB staff concludes that, despite all the efforts of management to date, there are too few signs that all plant personnel have fully accepted the need for a more involved role in day-to-day operations. It will need continued efforts by

all levels of supervisory staff to see that full involvement and accountability is achieved. Unfortunately this detracts from the achievements of those staff members who are dedicated and enthusiastic.

4.2 Pressure Tube Integrity

CANDU pressure tube integrity remains a major generic problem. The concerns regarding pressure tube deterioration were described fully in Board Member Document BMD 89-152. These remain an issue.

During the Unit 1 outage 53 tubes were inspected by CIGAR (Channel Inspection and Gauging Apparatus for Reactors) and scrape samples were obtained for hydrogen analysis. One pressure tube was found to have an unacceptably large flaw during this inspection process and was removed and replaced. This tube will be subjected to further testing at the Chalk River Laboratories of Atomic Energy of Canada Ltd.

During 1990 an improved method of obtaining hydrogen values was brought into service. This showed that the previous hydrogen levels used to predict tube blister thresholds were too high, and that the expected time for tubes in Unit 1, which are in contact with the calandria tube, to blister is now well beyond the planned retube date (1994). This revised methodology is to be applied to the data obtained from Unit 2 in 1989-90.

It is the opinion of AECB staff that pressure tube behaviour is now more predictable than it was at the beginning of 1990.

5. CONCLUSIONS

It is the opinion of AECB staff that overall performance standards at Bruce NGS"A" have continued to improve over the last year. However progress has not been as fast as the AECB or station management would have liked. Many of the initiatives remain as plans with not too much of substance produced. Trained resources have remained limited despite the influx of new staff.

The difficulties of maintaining and obtaining spares for an aging station are becoming significant. There is no doubt that these difficulties have been exacerbated by on-site stores policies which do not appear to be effective.

AECB staff is of the opinion that the ambitious plans for the rehabilitation of Bruce NGS"A" and for its return to a position amongst the world leading performers will not be achieved unless the problems mentioned in this report are overcome in the near future.

In view of the significant pressures imposed on Bruce NGS"A" to improve productivity, AECB staff considers that station management's consistent commitment to the principles of "safety first" is commendable. It is expected that this commitment will be maintained throughout the current year, when production pressures are expected to be even greater.

APPENDIX I

1990 SIGNIFICANT EVENTS REPORTABLE PURSUANT TO THE OPERATING LICENCE

90-003	Unit 4	Shutdown due to Large Heat Transport Leak
90-006	Unit 3	Steam Drum SOD Limit Exceeded
90-008	Unit 1	Impairment of Containment
90-014	Unit 0	Syphoning of Active Liquid Waste Tanks
90-015	Unit 2	Over-Pressurization of Shutdown Cooling System
90-016	Unit 2	Impairment of Back-Up Moderator Heat Sink
90-017	Unit 2	Unit Alert due to Tritium Hazard
90-018	Unit 2	Failure to Obtain Representative Gadolinium Sample
90-020	Unit 4	Unit Alert Spill of Moderator Water
90-025	Unit 0	Unit Alert D20 Drum Leak
90-029	Unit 2	Structural Failure of Moderator Cover Gas Heater
90-037	Unit 1	Spurious Initiation of ECI During Safety System Test
90-039	Unit 3	Shutdown due to Heat Transport Pump 3 Trip
90-046	Unit 0	Standby Generator Synchronized Out of Phase
90-047	Unit 2	Moderator D20 Exposure
90-048	Unit 3	Over-Pressurization of Boiler Feed Pump Suction
90-050	Unit 1	Unit Alert D20 Spill
90-051	All	Material Used on Nuclear Systems from Unqualified Units Supplier
90-052	Unit 2	Failure of SDS2 Detectors
90-062	Unit 4	Unit Alert Spill of Moderator Water
90-071	Unit 3	Steam Drum SOD Alarm
90-072	Unit 3	SDS1 Trip on Shut Down Unit
90-073	Unit 0	Spurious Operation of APRV
90-076	Unit 1	D20 Storage Tank Level Low
90-077	Unit 4	Impairment of P Trip
90-078	Unit 3	Impairment of P Trip
90-083	Unit 2	Leak on Liquid Zone System Compressor Piping
90-087	Unit 0	Impairment of ECI System
90-090	Unit 4	Unit Alert Moderator D20 Spill
90-091	Unit 2	Steam Drum SOD Alarm
90-095	Unit 1	Near Breach of Containment
90-100	Unit 3	Steam Drum SOD Alarm
90-101	Unit 3	Steam Drum SOD Alarm
90-109	Unit 3	Overpoison Guarantee Compromised
90-112	Unit 0	Pressure Boundary Violation
90-120	Unit 0	Impairment of Containment
90-122	Unit 2	Subcritical Operation of Reactor
90-124	Unit 3	Use of Non-Code Pressure Boundary Material
90-134	Unit 1,2&3	Use of Non-Standard Depleted Fuel
90-135	Unit 3	Shutoff Rod Power Supply Failure
90-136	Unit 4	Incorrect Fuelling Operation
90-139	Unit 2	Use of Incorrect Dummy Fuse

OBJECTIVE MEASURES OF STATION PERFORMANCE
BRUCE NGS'A'

	LAST YEAR'S VALUE	ACCEPTABLE	NEEDS ACTION
1. RADIATION CONTROL			
1.1 Occupational Safety			
1.1.1 Total Whole Body Dose 3.76 Sv	4.26	✓	—
1.1.2 Total Extremity Dose 7.87 Sv	5.57	✓ *	—
1.1.3 Total Fuel Handling Extremity Dose 1.61 Sv	.113	✓ *	—
1.1.4 Total Neutron Dose .84 mSv	.14	✓	—
1.1.5 Number of exposures > Regulatory Limits 0	0	✓	—
1.1.6 Number of radiation related supervisor's investigations 31	43	✓	—
1.2 Public Safety			
1.2.1 Releases from the Station			
a) Airborne			
Tritium No of weeks >1% DEL 0	8	✓	—
Average % DEL for year 0.42 %	0.6	✓	—
Noble Gas No of weeks >1% DEL 0	1	✓	—
Average % DEL for year 0.2 %	0.59	✓	—
Iodine 131 No of weeks >1% DEL 0	0	✓	—
Average % DEL for year .005 %	0.015	✓	—
Particulates No of weeks > 1% DEL 0	0	✓	—
Average % DEL for year .003 %	.0001	✓	—

* Acceptable when related to amount of reactor maintenance completed.

APPENDIX II

1.2.1 Continued		LAST YEAR'S VALUE	ACCEPTABLE	NEEDS ACTION
b) Waterborne				
Tritium	No of months > 1% DEL 0	0	✓	—
	Average % DEL for year .073 %	0.34	✓	—
Gross β	No of months > 1% DEL 0	0	✓	—
	Average % DEL for year .012	0.09	✓	—
c) Total Heavy Water Loss (if excessive, should be reflected in higher tritium releases)	5362 kg	15563	✓	—
d) Critical Adult Dose	6.2 μSv	8.6 μSv	✓	—
1.2.2 Environmental Measurements				
Average Boundary dose rate (Acceptable if within range of provincial reference sites value and not a significant increase from previous years)	44.7 nGy/hr	37 nGy/hr	✓	—
Average Boundary Tritium in Air (> .1% MPCa would indicate a marked increase and would require investigation)	.032 % MPCa	.052	✓	—
Average Tritium Concentration in Precipitation (average of all measurement sites)	295 Bq/l	484	✓	—
Average Gross β in Precipitation	41.8 $MGq/km^{-2}/mth$	36	✓	—
Average Tritium in Milk	26 Bq/l	32	✓	—

1.2.2 Continued

		LAST YEAR'S VALUE	ACCEPTABLE	NEEDS ACTION
Average C14 in Milk	274 Bq/l	230	✓	—
Average I131 in Milk	0.15 Bq/l	0.118	✓	—
Average Tritium in drinking water	22.5 Bq/l	37.5	✓	—
Average gross ß in drinking water	0.09 Bq/l	0.118	✓	—
Local water and fish samples			✓	—

Specific items for comment:

Traces of ^{137}Cs

^{134}Cs not detectable

Terrestrial Samples		—	✓	—

Specific items for comment:

H_3 lower than 1989

^{14}C slightly above background and higher than 1989

2. Plant Control		LAST YEAR'S VALUE	ACCEPTABLE	NEEDS ACTION
2.1	Number of Non-Spurious Reactor Trips/Unit 0	1.25	No Comment	
2.2	Number of Serious Process Failures/Unit 0	0	✓	
2.3	Special Safety System Unavailability (10^{-3} Years/Year)			

	This Year				Last Year				Predicted Future		
Unit:	1	2	3	4	1	2	3	4			
SDS1	0	0	0	0	0	0	0	0	0.219	✓	
SDS2	0	49.3*	0	0	0	0	0	0	1.30(1)		✓
Containment	78.7	78.7	78.7	78.7	383.6	383.6	383.6	383.6	1.723(2)		✓
ECI	.52	.52	.52	.52	331.6	383.6	383.6	383.6	3.04(3)		✓

2.4	Number of Reportable Incidents/Unit 8.2	14.5	✓	
2.5	Number of Fires 6**	4	✓	
2.6	Number of Significant Human Errors Reported 43	53	✓	
2.7	Plant Capacity Factor 47.4 %	53.55	No comment	
2.8	% AECB Compliance Inspections "Unsatisfactory"*** 38.5 %	48		✓

* Determined retrospectively where presence of non standard depleted fuel discovered.
** None serious.
*** Unsatisfactory relates to one or more items not in accordance with check list.
(1) Unavailability of poison injection valves.
(2) Airlock deficiencies due to equalizer valve problems.
(3) Uncompleted conversion of valve actuators.

		LAST YEAR'S VALUE	ACCEPTABLE	NEEDS ACTION
3.	**Plant Maintenance**			
3.1	Number of Unplanned Outages/Unit 3	1.25	No comment	
3.2	Number of Call-ups Outstanding at year-end 585	431	—	✓
3.3	Average of Monthly Deficiency Reports Outstanding/Unit 1093	1360	—	✓
4.	**Plant Administration**			
4.1	**Documentation**			
4.1.1	Average No. of Operating Memos in force/unit on 31 December 47	55	—	✓
4.1.2	Number of Memos extant > 6 months 129	88	—	✓
4.1.3	No. of systems (USI) with >1 Op Memo extant 12	15	✓	—
4.1.4	No. of Operating Memos behind schedule for review 72	18	—	✓
4.1.5	Total number of jumpers: 667	945	—	✓
4.2	**Training**			
4.2.1	% Scheduled drills completed 100%	90	✓	—
4.2.2	% Candidates passing AECB exams 97%	95	✓	—
4.3	**Security**			
4.3.1	Number of reportable security events 0	0	✓	—

4.4 Quality Assurance

	ACCEPTABLE	NEEDS ACTION
4.4.1 Results of AECB Audits		
1) Date July 1990	✓	___
2) Date _____	___	___
3) Date _____	___	___